arrangement of parts. The corallum is penetrated by an intercommunicating series of canals which put the cœlentera of all the polyps into communication with each other. The mouth is elongated in the sagittal axis. The stomatodœum is supported by twelve mesenteries. The two pairs of directive mesenteries, and one mesentery on each side (Nos. 4 and 9 of Fowler's Fig. 8)—which, as in the Antipatharia, may be termed the transverse mesenteries, and are the first to be developed—are more important than the others, and extend to a lower level; they are also the longest, and are the only ones which bear reproductive organs. Similar elongate mesenteries occur in Alyonaria, in Antipatharia, and in Seriatopora and Pocillopora amongst the Madreporaria. In Antipatharia, also, they are the only ones which bear reproductive organs. The present writer has more than once (Trans. Roy. Dublin Soc. iv. 1889, p. 300; Proc. R. D. S. 1890, vii. p. 128) suggested the employment of names for the primary mesenteries which are independent either of empirical numbers or of the order of their appearance in ontogeny. According to that enumeration, here, as in the Actiniaria generally, the first mesenteries to appear are the sulculo-sulcar laterals (Lacaze Duthiers' 1, and Fowler's 4 and 9). In *Madrepora Durvillei* the other important mesenteries are the sulculo-sulcular laterals and the sulcar directives, to which must be added in *M. aspera* the sulcular directives. The inconspicuous mesenteries are the sulco-sulcar laterals and the sulco-sulcular laterals (with the addition of the sulcular directives in *M. Durvillei*). There may be details of structure peculiar to certain species of Madrepora, or even to individuals, as in dimorphic forms; but the relative values of the several mesenteries can be matched in the young and in some adults of the Actiniaria, and in the larva of Euphyllia, and among other Madreporaria.

We cannot enter into the question of classification or the characters upon which classifications have been based; suffice it to say that Mr. Brook relies primarily on the structure of the corallum. Very little is yet known upon the arrangement of the soft tissues in their relation to the corallum. It is to be expected that the varied skeletal characters are the outcome of a difference in the structure or arrangement of the soft parts; in the meantime the corallum is all there is to deal with, and the author has naturally assumed that a similarity of structure involves a close relationship, and therefore places little reliance on habit. To a certain extent the species fall into well-marked groups, if one does not regard habit of prime importance. The genus is divided into ten divisions or sub-genera; the chief place is given to the character of the axial corallite (this is analogous to the growing point of the stem or branches of a plant), and secondly to that of the radial corallites which are produced by means of indirect budding around the wall of an axial corallite. The texture of the corallum is also an important diagnostic feature, and of least value is the mode of growth or habit. We are at present quite in the dark as to the reasons why individuals of the same species should grow in a flabellate (or palmate) manner, or be luxuriantly arborescent; there is, however, a general tendency for the members of a morphological group to have a similar habit of growth.

Those who have attempted to name specimens of madrepores from the older descriptions will welcome this masterly monograph; but it is to be regretted that outline figures illustrating the details employed in classification were not appended to the synopsis of the sub-genera on p. 22. The collotype plates, although beautifully executed, illustrate more the general habit, and the critical characters therein are not readily discerned.

The genus Madrepora contains a large number of species. Mr. Brook recognises 221, of which the British Museum has 180 species out of a total of over 1100 specimens. Mr. Brook reduced 169 old species to 130 in number, but has been obliged to describe 91 new species; of these 62 appeared in the *Annals of Natural History* for 1891 and 1892. No fossil representatives are alluded to. Mr. Brook had travelled extensively in Europe in order to study the type specimens in various museums, but he had not seen the types in American museums. Eighty-six species are illustrated in the twenty-five plates, which are beautiful collotypes by Messrs. Morgan and Kidd, from the author's own negatives. Owing to the necessity for large plates the monograph is quarto in size, instead of the usual octavo of the other catalogues of the British Museum.

It is by no means an easy task to identify the species of this genus, owing to their number and varied habit. The genus Madrepora is now flourishing abundantly, and it is difficult in some cases to determine whether certain forms should be regarded as species or varieties. It is widespread, abundant, and variable forms, such as these, which are the despair of old-fashioned systematists, but serve as stimulating problems for the modern naturalist.

ALFRED C. HADDON.

PHYSIOLOGICAL CHEMISTRY.

Physiological Chemistry of the Animal Body. By Arthur Gamgee, M.D., F.R.S. Vol. II. The Physiological Chemistry of Digestion. (London: Macmillan and Co., 1893.)

THE examination of the subject of physiological chemistry may obviously be made from two separate points of view. In the first place, the different problems of the subject may be discussed from the standpoint of the organic chemist, who looks to physiology for illustration and extension of truths established by laboratory practice. In the second place, the various chemical processes occurring in the animal body may be considered from the biological standpoint, and here the domain of chemistry is invaded simply as far as necessity compels for the adequate comprehension of the biological problems presented.

The result of writing a treatise from either of these points of view alone is to largely limit the usefulness of the work, and yet it requires no inconsiderable courage to attempt to furnish a work which may be of important service both to the chemist and biologist. Dr. Gamgee has, however, been inspired with the courage of his well-recognised ability, and has presented the scientific world with a work which must at once appeal to the chemist for the thoroughness of its chemical explanation and detail, and to the biologist for the general completeness of its critical review of physiological work.

Dr. Gamgee expresses the hope that the text-book may supply a want which is at present experienced of some guide to the more advanced student and original worker. The fulness of the references given in the work alone would warrant this hope being fulfilled; and the fact that some of the most recent work is included in the volume will not lessen its anticipation. The author has not confined himself to purely physiological considerations. The pathology of jaundice, the pharmacology of icterogenic poisonous agents, the formation of gall-stones, and the nature of the gastric contents in different pathological conditions, are all treated with an amount of fulness that might not be expected in a work on physiological chemistry.

In addition to the general record and criticism of physiological work, all the important analytical methods are supplied, and it will be to some an encouragement to know that Dr. Gamgee has himself tried, as far as possible, all the experimental processes mentioned.

The present volume does not complete Dr. Gamgee's treatise on physiological chemistry. He proposes, after re-editing the first volume, to finish his work with yet another volume giving the results of a study from the chemical point of view of other animal functions. We may be permitted to express the hope that circumstances will favour the elapse of a much shorter interval than has occurred between the publication of volumes i. and ii. At the same time, the vast amount of important work that has been done during the last decade, and which has largely revolutionised our ideas of the physiological chemistry of digestion, makes the present time auspicious for the presentation of a record of such work.

The present volume is divided into thirteen chapters of varying length. The first is occupied with a consideration of *saliva*. The most recent views as to the constitution of the starch molecule, and the results of the action upon it of a diastatic ferment, are well described.

The second chapter, however, which treats of gastric digestion, will probably be regarded as the most important in the book. It commences with a short histological account of the structure of the stomach. We think that these short histological descriptions are out of place in the present work; they are not sufficiently full to be of much value to those who are likely to have occasion to use the book. The histological preliminaries are succeeded by a historical account of our knowledge concerning gastric digestion, in which the views of Van Helmont, Sylvius, Borelli, Réaumur, and Spallanzani are recorded. The nature of pepsin, the method of preparing artificial gastric juice, the nature of the acid of the stomach, are all treated upon with considerable detail. Then follows an account of the changes occurring in proteids by the action of gastric juice. After referring to the views of Meissner, Brücke, and Schutzenberger, the author goes on to record the observations and views of Kühne. The large amount of work done in recent years by Kühne, Chittenden, and Neumeister in the direction of refining our knowledge of what a few years ago was called *peptone*, is fully described. We are disposed, however, to take part with Halliburton in preferring the term *proteose* to that of *albumose*. Dr. Gamgee considers that a confusion might arise between the term *proteose* and *proto-albumose*, and prefers the general term *albumose*. But the difficulty at present experienced of causing students to understand that albumose can be derived from other proteids than albumin makes the confusion suggested by Dr. Gamgee a comparatively insignificant matter. When the terms *globulose*, *caseose*, and so on exist, it is obviously unscientific to retain the term albumose as embracing all these bodies. We are hopeful, therefore, that the change suggested by Halliburton will gradually find its way into our physiological text-books.

The milk-curdling enzyme of the stomach is referred to, and a brief account of the change that milk undergoes by its action is given. Dr. Gamgee prefers to leave a detailed consideration of these changes to a later volume dealing generally with the chemistry of milk. We think it is more desirable to treat of the change milk undergoes at the instance of a ferment in the stomach in connection with gastric digestion than at any other place. There is a rather unaccountable inconsistency in Dr. Gamgee's reference to absorption of water in the stomach. On p. 154 he states in the paragraph indicator that the stomach is "the seat of absorption of much water." In surveying the work on this subject later (p. 439 *et seq.*) he describes how recent research has established beyond a doubt the fact that the stomach does not absorb water at all (p. 441, line 20).

The third chapter treats very fully of pancreatic digestion, and appears with that on bile (chapter iv.) to be amongst the best in the volume. In connection with the latter the author has given us some very beautiful reproductions of MacMunn's spectra of bile-derivatives. The nature of the albuminoid substance of bile is referred to, and the fact that it is no longer to be regarded as *mucin*, but as a *nucleo-albumin*, is emphasised. The nature of nucleo-albumin is also briefly described. The digestive processes occurring in the small intestine are treated of in chapter ix. The different methods of experimenting are fully described. As regards the action of the enzyme of the intestinal juice, we think Dr. Gamgee has been somewhat over-influenced by tradition, which has led him to attach perhaps too much importance to its existence and action. And the fact that observers have always experienced more difficulty in obtaining positive results with extracts of the fresh mucous membrane than with so-called intestinal juice, justifies us in accepting with considerable caution inferences based upon observations on so-called permanent fistulæ.

The last chapter is devoted to a description of intracellular digestion in lower invertebrata, the digestion occurring in fishes, birds and ruminants, and supplies a becoming sequel to a comprehensive work.

Appendices are added, giving in more detail Neumeister's views concerning the albumoses, some very recent work of Kühne on the separation of albumoses and peptones; also some additional methods for the detection and estimation of the acidity of the stomach.

We should have preferred to see the index divided into two portions—one treating of subjects and the other of authors. A few mistakes occur in it, but only of trifling importance; however, it has the defect of being somewhat incomplete.

Taken altogether, we have only congratulation to offer to Dr. Gamgee on the production of this work, and have no hesitation in stating that he is certainly justified in hoping, as he does in the preface, "that the present volume may . . . further the advancement of, and prove not altogether unworthy of, the present position of Physiology in England." J. S. EDKINS.

AN ESSAY ON NEWTON'S "PRINCIPIA."

An Essay on Newton's "Principia." By W. W. Rouse Ball. (London: Macmillan and Co., 1893.)

THE name of Newton has become now quite a household word amongst us, and one instance of its familiarity was strikingly brought home in an answer given by a small child, who when asked who was Newton, replied, "the man who found the first apple!" That two important epochs in the world's history should have been marked by the presence of this fruit, seems curious indeed; and Mr. Ball informs us that the apple anecdote in Newton's case rests on good authority, for besides written evidence, local tradition confirms it by the careful treatment the tree received, which kept it alive until the year 1820.

For the essay which we have before us, Mr. Ball should receive the thanks of all those to whom the name of Newton recalls the memory of a great man. The "Principia," besides being a lasting monument of Newton's life, is also to-day the classic of our mathematical writings, and will be so for some time to come. During Newton's lifetime three editions of this great work were brought out, the first appearing in 1687; the second, edited by Cotes, in 1713; and the third, by Pemberton, in 1726. Since the last-mentioned date, the history of the "Principia" has been discussed by Sir David Brewster and Prof. S. P. Rigaud, but both of these works are now out of print and very scarce. At the present time, as Mr. Ball informs us, it seems fitting to collect, from these and other sources, the references to the leading events in the preparation and publication of the "Principia," and the present volume contains the result of his labours. In the subject-matter, of course, there is much that is not new, but the value of the work lies in the fact that, besides containing a few as yet unpublished letters, there are collected in its pages quotations from all documents, thus forming a complete summary of everything that is known on the subject.

Mr. Ball divides his essay into six main sections, dealing with Newton's investigations in 1666, in 1679, in 1684, in 1685–1687, compilation and publication of the "Principia," the two last treating of the contents of the "Principia," and the subsequent history and preparation of later editions.

Mr. Ball commences with the works of Newton at the time when the latter had taken his degree at Cambridge, and therefore had more leisure to pursue his studies in his own way. The reader is made acquainted with Newton's early views, and there are several interesting quotations from some original manuscripts inserted. The investigations of 1879 refer, in great part, to the correspondence he had with Hooke, which turned his attention to the problem of planetary motion. It was in this year that Newton suggested the method of demonstrating the earth's motion of rotation on its axis by the letting fall of a stone from a high position, and observing the direction of the deviation from the vertical; he also repeated his calculations (with new data) for finding the relation between terrestrial gravity and the centripetal force which retained the moon in her orbit.

In 1684, Halley, after attempting to deduce the motion of the heavenly bodies from Kepler's laws, with unsuccessful results, made a visit to Cambridge, when he found that Newton "had brought this demonstration to perfection." During that year Newton gave in his professional lectures an account of his work then in manuscript form, entitled, "De Motu Corporum," which may be said to be "a rough draft of the beginning of the first book of the 'Principia.'" This period includes also Halley's second visit to Cambridge with reference to Newton's publication of this tract, and it was at this time also that Halley asked him to communicate his results to the Royal Society. The tract which Newton finally communicated was entitled, "Propositiones de Motu," and may be looked upon as marking the point at which Newton had arrived about the end of this year. Mr. Ball reproduces this tract *in extenso*, as it has only once been printed, and copies of it are scarce.

The fifth chapter deals with the investigations from 1685 to 1687, during which time Newton was preparing the "Principia." A most interesting account is given of the details concerned in the preparation of the subject-matter, while he refers also, by no means too fully, to the extreme generosity that Halley displayed, both as regards the cost of printing the books, and also to the interest he took in their progress, criticising some parts, and revising sheets for press. Rigaud, in his essay on the first publication of the "Principia," referring to this point, says, "that under the circumstances it is hardly possible to form a sufficient estimate of the immense obligation which the world owes in this respect to Halley, without whose great zeal, able management, unwearied perseverance, scientific attainments, and disinterested generosity the 'Principia' might never have been published." Mr. Ball also discusses here briefly Newton's controversy with Hooke, "the universal claimant," as he was called.

Chapter vi. is devoted to an analysis of the "Principia," a few words of introduction relating to the main differences between the first editions being given. Mr. Ball limits himself in the main to a statement of the propositions, lemmas, &c., but occasionally he breaks in with a few words of explanation, or of historical interest.

The remaining period, ending with the year 1726, contains matter dealing with the large correspondence Newton had on the contents of his "Principia," to his revision of the whole work, the extension of some of the results, and finally to the preparations of the two later editions.

The appendices contain the correspondence between Newton and Hooke and Halley, besides some memoranda on the correspondence concerning the production of the second and third editions.

From the above brief sketch of the contents of this essay, our readers may perhaps gather some idea of the ground it covers. The author is so well known a writer on anything connected with the history of mathematics, that we need make no mention of the thoroughness